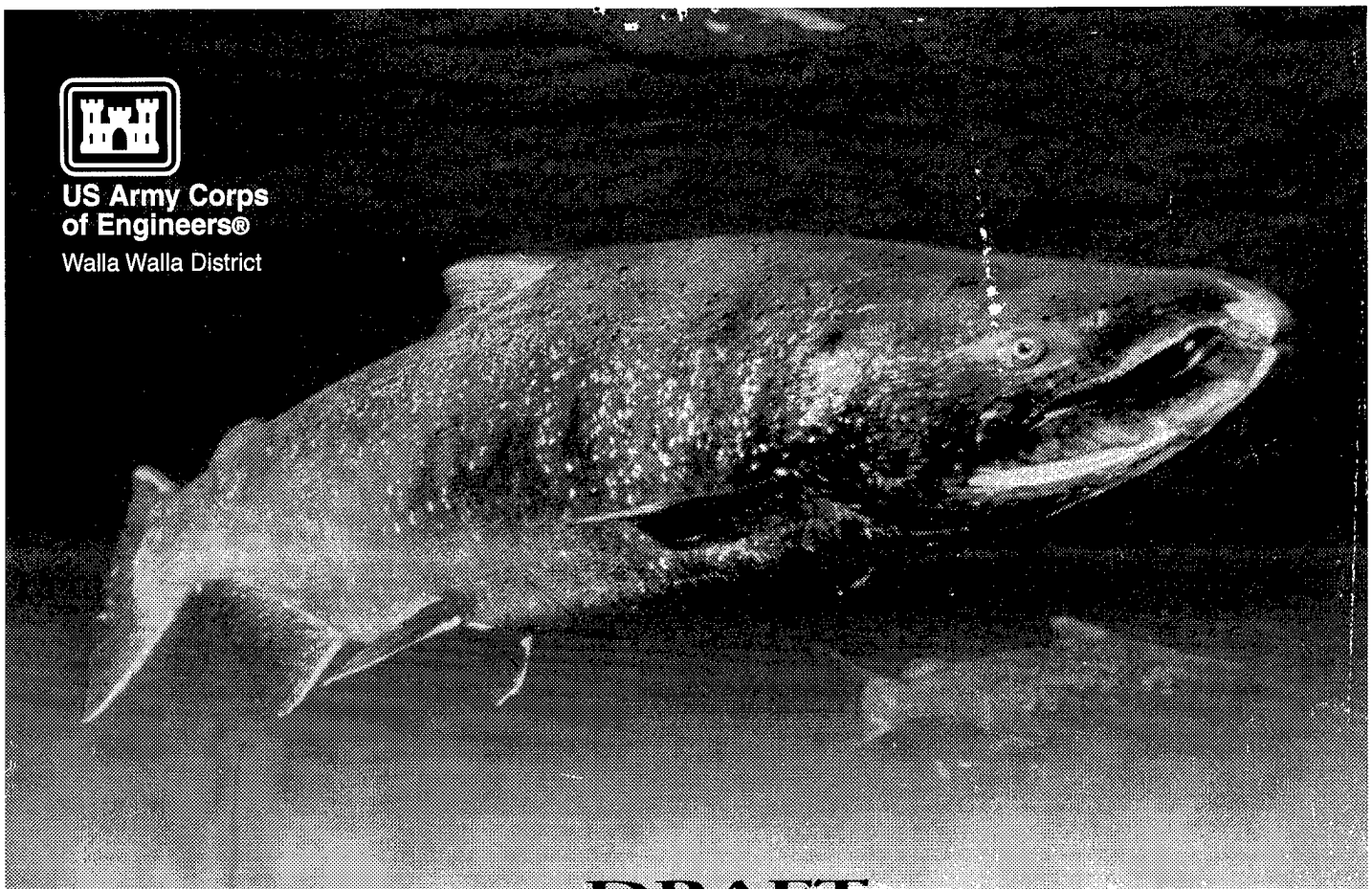

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Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement

APPENDIX R
Historical Perspectives

December 1999

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 17, 1999	Draft 17 Dec 99 - 31 Apr 00

4. TITLE AND SUBTITLE
Lower Snake River Juvenile Salmon Migration Feasibility Report and Environmental Impact Statement (Draft FR/EIS) Appendix R Historical Perspectives

5. FUNDING NUMBERS

6. AUTHOR(S)
US Army Corps of Engineers, Walla Walla District

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
US Army Corps of Engineers, Walla Walla District

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
US Army Corps of Engineers, Walla Walla District

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Public Comment period began 17 Dec 99 and ended 30 Apr 00.

Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The Corps of Engineers along with the Bonneville Power Administration, US Environmental Protection Agency, and US Bureau of Reclamation as cooperating agencies, analyzed four general alternatives intended to provide information on the technical, environmental, and economic effects of actions related to improving juvenile salmon passage. The four alternatives include Alternative 1 - Existing Conditions (the no-action alternative) and three different ways to further improve juvenile salmon passage. The action alternatives are: Alternative 2 - Maximum Transport of Juvenile Salmon, Alternative 3 - Major System Improvements, and Alternative 4 - Dam Breaching. Comparison of the alternatives by all of the factors assessed in the study has not offered a clear-cut recommendation at this time. It is the Corps of Engineer's intent to recommend a preferred plan of action in the Final FR/EIS.

14. SUBJECT TERMS
Lower Snake River Project
Endangered Species Act
Fish Passage

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

FEASIBILITY STUDY DOCUMENTATION

Document Title	
Summary to the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement	
Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement	
Appendix A	Anadromous Fish
Appendix B	Resident Fish
Appendix C	Water Quality
Appendix D	Natural River Drawdown Engineering
Appendix E	Existing Systems and Major System Improvements Engineering
Appendix F	Hydrology/Hydraulics and Sedimentation
Appendix G	Hydroregulations
Appendix H	Fluvial Geomorphology
Appendix I	Economics
Appendix J	Plan Formulation and Decision Analysis Model
Appendix K	Real Estate
Appendix L	Lower Snake River Mitigation History and Status
Appendix M	Fish and Wildlife Coordination Act Report
Appendix N	Cultural Resources
Appendix O	Public Outreach Program
Appendix P	Air Quality
Appendix Q	Tribal Consultation/Coordination
Appendix R	Historical Perspectives
Appendix S	Snake River Maps
Appendix T	Biological Assessment
Appendix U	Clean Water Act, Section 404(b)(1) Evaluation

The documents listed above, as well as supporting technical reports and other study information, are available on our website at www.nww.usace.army.mil. Copies of these documents are also available for public review at various city, county, and regional libraries.

FOREWORD

This appendix is one part of the overall effort of the U.S. Army Corps of Engineers (Corps) to prepare the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (FR/EIS).

Please note that this document is a DRAFT appendix and is subject to change and/or revision based on information received through comments, hearings, workshops, etc. After the comment period ends and hearings conclude a Final FR/EIS with Appendices is planned.

The Corps has reached out to regional stakeholders (Federal agencies, tribes, states, local governmental entities, organizations, and individuals) during the development of the FR/EIS and appendices. This effort resulted in many of these regional stakeholders providing input, comments, and even drafting work products or portions of these documents. This regional input provided the Corps with an insight and perspective not found in previous processes. A great deal of this information was subsequently included in the Draft FR/EIS and Appendices, therefore, not all the opinions and/or findings herein may reflect the official policy or position of the Corps.

STUDY OVERVIEW

Purpose and Need

Between 1991 and 1997, due to declines in abundance, the National Marine Fisheries Service (NMFS) made the following listings of Snake River salmon or steelhead under the Endangered Species Act (ESA) as amended:

- sockeye salmon (listed as endangered in 1991)
- spring/summer chinook salmon (listed as threatened in 1992)
- fall chinook salmon (listed as threatened in 1992)
- steelhead (listed as threatened in 1997)

In 1995, NMFS issued a Biological Opinion on operations of the Federal Columbia River Power System. The Biological Opinion established measures to halt and reverse the declines of these listed species. This created the need to evaluate the feasibility, design, and engineering work for these measures.

The U.S. Army Corps of Engineers (Corps) implemented a study after NMFS's Biological Opinion in 1995 of alternatives associated with lower Snake River dams and reservoirs. This study was named the Lower Snake River Juvenile Salmon Migration Feasibility Study (Feasibility Study). The specific purpose and need of the Feasibility Study is to evaluate and screen structural alternatives that may increase survival of juvenile anadromous fish through the Lower Snake River Project (which includes the four lowermost dams operated by the Corps on the Snake River—Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams) and assist in their recovery.

Development of Alternatives

The Corps completed an interim report on the Feasibility Study in December 1996. The report evaluated the feasibility of drawdown to natural river levels, spillway crest, and other improvements to existing fish passage facilities. Based in part on a screening of actions conducted in the interim report, the study now focuses on four courses of action:

- Existing conditions (currently planned fish programs)
- System improvements with maximum collection and transport of juveniles (without major system improvements such as surface bypass collectors)
- System improvements with maximum collection and transport of juveniles (with major system improvements such as surface bypass collectors)
- Dam breaching or permanent drawdown to natural river levels for all reservoirs

The results of these evaluations are presented in the combined Feasibility Report (FR) and Environmental Impact Statement (EIS). The FR/EIS provides the support for recommendations that will be made regarding decisions on future actions on the Lower Snake River Project for passage of juvenile salmonids. This appendix is a part of the FR/EIS.

Geographic Scope

The geographic area covered by the FR/EIS generally encompasses the 140-mile long lower Snake River reach between Lewiston, Idaho and the Tri-Cities in Washington. The study area does slightly vary by resource area in the FR/EIS because the affected resources have widely varying spatial characteristics throughout the lower Snake River system. For example, socioeconomic effects of a permanent drawdown could be felt throughout the whole Columbia River Basin region with the most effects taking place in the counties of southwest Washington. In contrast, effects on vegetation along the reservoirs would be confined to much smaller areas.

Identification of Alternatives

Since 1995, numerous alternatives have been identified and evaluated. Over time, the alternatives have been assigned numbers and letters that serve as unique identifiers. However, different study groups have sometimes used slightly different numbering or lettering schemes and this has lead to some confusion when viewing all the work products prepared during this long period. The primary alternatives that are carried forward in the FR/EIS currently involve four major alternatives that were derived out of three major pathways. The four alternatives are:

Alternative Name	PATH[1/] Number	Corps Number	FR/EIS Number
Existing Conditions	A-1	A-1	1
Maximum Transport of Juvenile Salmon	A-2	A-2a	2
Major System Improvements	A-2'	A-2c	3
Dam Breaching	A-3	A-3a	4

[1/] Plan for Analyzing and Testing Hypotheses

Summary of Alternatives

The **Existing Conditions Alternative** consists of continuing the fish passage facilities and project operations that were in place or under development at the time this Feasibility Study was initiated. The existing programs and plans underway would continue. Project operations, including all ancillary facilities such as fish hatcheries and Habitat Management Units (HMUs) under the Lower Snake River Fish and Wildlife Compensation Plan (Comp Plan), recreation facilities, power generation, navigation, and irrigation would remain the same unless modified through future actions. Adult and juvenile fish passage facilities would continue to operate.

The **Maximum Transport of Juvenile Salmon Alternative** would include all of the existing or planned structural and operational configurations from the Existing Conditions Alternative. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport from Lower Granite, Little Goose, and Lower Monumental and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor). To accommodate this maximization of transport some measures would be taken to upgrade and improve fish handling facilities.

The **Major System Improvements Alternative** would provide additional improvements to what is considered under the Existing Conditions Alternative. These improvements would be focused on using surface bypass collection (SBC) facilities in conjunction with extended submersible bar screens (ESBS) and a behavioral guidance system (BGS). The intent of these facilities is to provide more effective diversion of juvenile fish away from the turbines. Under this alternative the number of fish collected and delivered to upgraded transportation facilities would be maximized at Lower Granite, the most upstream dam, where up to 90 percent of the fish would be collected and transported.

The **Dam Breaching Alternative** has been referred to as the "Drawdown Alternative" in many of the study groups since late 1996 and the resulting FR/EIS reports. These two terms essentially refer to the same set of actions. Because the term drawdown can refer to many types of drawdown, the term dam breaching was created to describe the action behind the alternative. The Dam Breaching Alternative would involve significant structural modifications at the four lower Snake River dams allowing the reservoirs to be drained and resulting in a free-flowing river that would remain unimpounded. Dam breaching would involve removing the earthen embankment sections of the four dams and then developing a channel around the powerhouses, spillways, and navigation locks. With dam breaching, the navigation locks would no longer be operational, and navigation for large commercial vessels would be eliminated. Some recreation facilities would close while others would be modified and new facilities could be built in the future. The operation and maintenance of fish hatcheries and Habitat Management Units (HMUs) would also change although the extent of change would probably be small and is not known at this time. Project development, design, and construction span a period of nine years. The first three to four years concentrate on the engineering and design processes. The embankments of the four dams are breached during two construction seasons at year 4-5 in the process. Construction work dealing with mitigation and restoration of various facilities adjacent to the reservoirs follows dam breaching for three to four years.

Authority

The four Corps dams of the lower Snake River were constructed and are operated and maintained under laws that may be grouped into three categories: 1) laws initially authorizing construction of the project, 2) laws specific to the project passed subsequent to construction, and 3) laws that generally apply to all Corps reservoirs.

BOUNDARIES

State

County

KM 300 100 0 MILES 7.5 15 30

125,000 ACRES

GEOGRAPHIC INFORMATION SYSTEMS
Corps of Engineers
Walla Walla District

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Lower Snake River

Juvenile Salmon Migration Feasibility Study

REGIONAL BASE MAP

1999

GIS Analysts & Graphic Assembly: Applied Technology Team (CENWW-PM-PD-EJ)
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ABSTRACT

This appendix provides a historical perspective on significant events and documents of the 1990s that are related to salmon restoration efforts in the Federal Columbia River Power System. It has been prepared by Foster Wheeler Environmental Corporation. Included in this appendix is a discussion of the study driving the need for this EIS, the System Configuration Study (SCS). The U.S. Army Corps of Engineers initiated the SCS in 1991 to evaluate the technical, environmental, and economic effects of potential modifications to the configuration of Federal dams and reservoirs, with the goal of improving survival rates for anadromous salmonids migrating downriver.

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Draft
Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement

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Appendix R
Historical Perspectives

Produced by
Foster Wheeler Environmental Corporation

Produced for
U.S. Army Corps of Engineers
Walla Walla District

Completed October 1999
Revised and released for review
with Draft FR/EIS
December 1999

TABLE OF CONTENTS

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ACRONYMS AND ABBREVIATIONS

ANCOOR	Analytical Coordination Workgroup
BA	Biological Assessment
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
CEQ	Council on Environmental Quality
Corps	U.S. Army Corps of Engineers
EIS	environmental impact statement
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
FR	Federal Register
IDFG	Idaho Department of Fish and Game
IDFG v. NMFS	Idaho Department of Fish and Game v. Natural Marine Fisheries Service
ISG	Independent Scientific Group
MOA	Memorandum of Agreement
MOP	minimum operating pool
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPPC	Northwest Power Planning Council
OA/EIS	Columbia River Salmon Flow Measures Options Analysis/Environmental Impact Statement
PATH	Process for Analyzing and Testing Hypotheses
PNCA	Pacific Northwest Coordination Agreement
ROD	Record of Decision
SCS	System Configuration Study
SEIS	Supplemental Environmental Impact Statement
SOR	System Operation Review
SOS	System Operating Strategies
SRSRT	Snake River Salmon Recovery Team
TAG	Technical Advisory Group
USFWS	U.S. Fish and Wildlife Service

Executive Summary

This appendix provides a historical perspective on significant events and documents of the 1990s that are related to salmon restoration efforts in the Federal Columbia River Power System.

The first significant event of the 1990s was the Northwest Salmon Summit, which was convened in 1990 to address the problem of declining salmon stocks and to reach a consensus among diverse Pacific Northwest interests.

In the ensuing years, three species of Northwest anadromous fish were listed as threatened or endangered on the Snake River: sockeye salmon were listed as endangered in 1991; chinook were listed as threatened in 1992; and steelhead were classified as threatened in 1996.

Many agencies and groups are involved in the anadromous fish issues of the Columbia River Basin. These include the U.S. Army Corps of Engineers (Corps), Bonneville Power Authority (BPA), National Marine Fisheries Service (NMFS), Bureau of Reclamation, and U.S. Fish and Wildlife Service (USFWS). Additionally, several groups have formed specifically to study these issues:

- Northwest Power Planning Council (NPPC) formed in 1980 and composed of representatives from Idaho, Montana, Oregon, and Washington. The NPPC is responsible for finding ways to acquire and market new power sources while giving equitable treatment to fish and wildlife. The NPPC issued the Columbia River Basin Fish and Wildlife Program, which addresses salmon and steelhead production, safe passage, and harvest management, resident fish and wildlife protection, future hydroelectric development, and coordination among Federal Agencies responsible for Columbia River Basin resources. The Program was issued in 1982 and amended in 1991.
- Snake River Salmon Recovery Team (SRSRT) appointed by NMFS to independently develop recommendations for a recovery plan for the Snake River sockeye and chinook salmon. NMFS used these recommendations in the development of the Recovery Plan, issued in 1995.
- Independent Scientific Group (ISG) funded by BPA to conduct a biennial review of the science underlying salmon and steelhead recovery efforts. The ISG issued a 1996 report that provides a scientific foundation for public policy to be developed by NPPC.
- Analytical Coordination Work Group (ANCOOR) which consists of fishery modelers from NMFS, BPA, NPPC, the Corps, states, and tribes. The objective of this group is to compare and enhance smolt passage survival and lifecycle models used within the region. The group was formed in 1993.

Several Environmental Impact Statements and related documents have been developed by the Corps in the 1990s, with the Bonneville Power Authority, Bureau of Reclamation, or NMFS as cooperating agencies:

- *Columbia River Salmon Flow Measures Options Analysis/EIS* (issued in 1992) evaluated the effects of operational changes at certain Federal multipurpose water projects in the Federal Columbia River Power System. The Corps also prepared a biological assessment of whether the proposed actions would jeopardize listed species. NMFS reviewed this information and issued a biological opinion that the proposed operations were not likely to jeopardize the

existence of listed or proposed salmon species. The Corps then issued a Record of Decision that described its Operations Plan for 1992.

- *The Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Final Supplemental Environmental Impact Statement* was prepared by the Corps in 1993. It addressed issues similar to the 1992 EIS, but evaluated effects of actions occurring over a longer period of time and included some projects not addressed in the 1992 OA/EIS. The preferred alternative recommended some changes to the 1992 Operating Plan. Included in the alternatives was a drawdown test of Lower Granite Dam on the lower Snake River. A companion EIS was developed specifically for this series of tests, but was never completed because juvenile salmon were shown to have a high survival rate (over 90 percent) through the dam.
- NMFS issued two more biological opinions on operations of the Columbia River System: the 1993 biological opinion was based on 1993 operations, and the 1994 biological opinion was based on operations from 1994 through 1999. Again, both opinions ultimately indicated that operations were not likely to jeopardize the continued existence of the endangered or threatened Snake River salmon. After the 1993 opinion was challenged and overturned in the courts, NMFS issued a new opinion in 1995 indicating that operations were likely to jeopardize the salmon and that long-term system reconfigurations were necessary. The opinion also included an alternative to the proposed action of the 1993 EIS; this alternative requested that the Corps evaluate one of three drawdown scenarios and implement surface collectors. In 1995, the Corps issued a ROD that stated its intentions to follow through with NMFS's recommendations as quickly as possible.
- The *Columbia River System Operation Review* (SOR) was initiated in 1990 by the Corps, BPA, and the Bureau of Reclamation to review multipurpose management of the Columbia-Snake River System and provide a strategy for system operation. The final EIS was issued in 1995.
- The *System Configuration Study* was initiated by the Corps in 1991 to evaluate the technical, environmental, and economic effects of potential modifications to the configuration of Federal dams and reservoirs. The *Lower Snake River Juvenile Salmon Migration Feasibility Study*, described in this EIS, is one of several studies conducted under this program. This study was initiated in 1994 to specifically evaluate the technical, environmental, social, and economic effects of potential modification to four projects on the lower Snake River. Additional studies are evaluating other projects on the two rivers.

Timeline

of Salmon Recovery Efforts for the Federal Columbia River Power System

1990

- **April** — Petition submitted to list Snake River sockeye as endangered under ESA
- **June** — Petition submitted to list Snake River spring/summer and fall chinook as threatened under ESA
- **July** — Columbia River SOR initiated
- **October** — Salmon Summit begins

1991

- **November** — Snake River sockeye listed as endangered under ESA
- **December** — NPPC, Phase II Amendments to Fish and Wildlife Program completed and issued

1992

- **January** — Columbia River Salmon Flow Measures OA/EIS issued
- **February** — Corps issues ROD to implement drawdown test of Lower Granite and Little Goose Reservoirs
- **March** — Corps conducts drawdown test of Lower Granite and Little Goose Reservoirs
- **March** — System Configuration Study, Phase I initiated
- **April** — Snake River spring/summer and fall chinook listed as threatened under ESA
- **April** — NMFS issues "no jeopardy" BO on Proposed 1992 Operations of FCRPS
- **April** — Corps issues ROD on Proposed 1992 Operations of the FCRPS

1993

- **March** — Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Supplemental EIS issued
- **May** — NMFS issues "no jeopardy" BO on Proposed 1993 Operations of the FCRPS
- **June** — Corps issues ROD on Proposed 1993 Operations of the FCRPS
- **December** — ESA critical habitat for Snake River sockeye, spring/summer chinook, and fall chinook designated
- **Throughout Year** — Formation of regional forums began providing input into the salmon processes (i.e., PATH)

Timeline of Salmon Recovery Efforts for the Federal Columbia River Power System (cont'd.)

1994

March
NMFS issues "no jeopardy" BO on Proposed 1994–1999 Operations of the FCRPS

April
Federal District Court sets aside NMFS' BO on Proposed 1993 Operations of FCRPS and the Corps and BoR RODs, and orders preparation of new BO and RODs

August
NMFS issued a proposed rule to list spring/summer chinook and fall chinook as endangered but later (1998) withdrew it, leaving the stocks listed as threatened

April
Lower Snake River Biological Drawdown Test Draft EIS issued

May
Snake River Salmon Recovery Team issues final recommendations to NMFS

November
Lower Snake River Juvenile Salmon Migration Feasibility Study initiated as part of the System Configuration Study, Phase II

1995

March
NMFS issues new BO on 1995–1998 operation of FCRPS finding jeopardy to listed salmon stocks and recommending "Reasonable and Prudent Alternatives"

March
Corps issues ROD on FCRPS Operation for 1995 and future years

March
NMFS issues Proposed Recovery Plan for Snake River salmon

November
Final EIS for the Columbia River SOR issued

1996

August
(formal listing occurred in August 1997)
Snake River wild steelhead proposed for threatened listing under ESA

September
Independent Scientific Group review of NPPC's Fish and Wildlife Program issued

December
Lower Snake River Juvenile Salmon Migration Feasibility Study, Interim Status Report issued

1. Introduction

The U.S. Army Corps of Engineers' (Corps) *Lower Snake River Juvenile Salmon Migration Feasibility Study* (the current study) was initiated in 1994 to evaluate the technical, environmental, social, and economic effects of potential modifications to the configuration (structural components and their arrangement) of four federal facilities (Ice Harbor, Lower Monumental, Little Goose, Lower Granite) on the lower Snake River. The intent of these modifications is to increase the survival of juvenile anadromous fish as they migrate through the lower Snake River system.

The current study is not an isolated project. It is one part of a large, multiyear, multiagency effort to restore salmon stocks in the Federal Columbia River Power System (FCRPS). The Corps is playing a significant role in this effort, along with the Bonneville Power Administration (BPA), the Bureau of Reclamation (BOR), the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS). To understand the purpose, role, and goals of this specific study, it is helpful to understand the general historical and technical context. This historical perspective document is intended to provide that context by summarizing significant events and documents from 1990 to the present related to salmon restoration efforts in the FCRPS. The most significant events and documents are highlighted on the preceding timeline.

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2. Details of Significant Events and Documents

This section summarizes significant events and documents related to the Corps' management of projects on the lower Snake River since 1990, when the Salmon Summit was convened and the NMFS was first petitioned to list Snake River sockeye (*Oncorhynchus nerka*) as endangered under the Endangered Species Act (ESA). The events and documents have been discussed, to the extent possible, in chronological order, although many significant activities have occurred simultaneously.

2.1 Salmon Summit

Senator Mark Hatfield of Oregon organized the Northwest Salmon Summit in Portland in 1990 to explore various ideas for fish protection (Mighetto and Ebel, 1994). Conducted before any Snake River salmon populations were listed under the ESA, the Summit intended to reach a consensus among Pacific Northwest interests and formulate a plan to address the problem of declining salmon stocks. In addition, participants were expected to suggest an appropriate response to NMFS' pending ESA listing of salmon. The Summit included the governors of Washington, Oregon, Idaho, and Montana, as well as 30 official members representing 28 organizations responsible for water management, power production or marketing, and fisheries management.

Participants divided into four separate task groups to study fish harvest, river flow, salmon production, and enforcement problems. The meetings began in October 1990 and continued into 1991. Although members developed various proposals, the divergent interests represented at the Summit did not reach an agreement on a fundamental approach to the problem. By the last formal meeting, held in early March 1991, Summit participants had not reached a consensus on a comprehensive plan of action or mitigation of impacts.

One of the most controversial proposals to emerge from the Summit was the idea of drawing down the reservoirs on the lower Snake River by as much as 30 meters (100 feet) or more (Mighetto and Ebel, 1994). Proponents believed that increased spill and water velocity during the spring migration would "flush" juvenile fish downstream, reducing their journey of approximately 30 days to 16 or 17 days. They believed that reduced migration time would increase survival by, among other things, decreasing the amount of time fish were exposed to predators. In 1991, it seemed that Summit participants reached an agreement for a one-year implementation plan. However, concern for adverse impacts of lowered water levels on shipping, port operation, recreation, and farming reduced the scope of actions agreed upon. Although the Salmon Summit failed to agree on a plan to save the salmon, the meetings contributed to the NMFS decision not to invoke an emergency listing for the sockeye salmon. Although the Summit's efforts did not prevent the ESA final listing, it did succeed in bringing a broad array of interests into recovery discussions. Participants, including the Corps, agreed to continue efforts to rebuild the depleted Columbia-Snake River system salmon stocks.

2.2 Endangered Species Act Listings for Northwest Salmon

On April 2, 1990, the NMFS received a petition from the Shoshone Bannock Tribes of the Fort Hall Reservation, Idaho, to list Snake River sockeye as endangered under the ESA [Snake River Salmon Recovery Team (SRSRT), 1994]. On June 7, 1990, NMFS received petitions from Oregon Trout, with co-petitioners Oregon Natural Resources Council, the Northwest Environmental Defense

Center, American Rivers, and the Idaho and Oregon chapters of the American Fisheries Society to list Snake River spring chinook, Snake River summer chinook, and Snake River fall chinook (*O. tshawytscha*) under the ESA (SRSRT, 1994).

NMFS published notices on June 5, 1990 (55 Federal Register [FR] 22942) and September 11, 1990 (55 FR 37342) stating that the petitions presented substantial scientific information indicating that the listings may be warranted (SRSRT, 1994). NMFS initiated a review of the status of each fish, and requested further biological information from the public. Status reviews for Snake River sockeye (Waples et al., 1991a), Snake River spring/summer chinook (Matthews and Waples, 1991), and Snake River fall chinook (Waples et al., 1991b) compiled the scientific information that led to the proposed listing of Snake River sockeye as endangered, and Snake River spring/summer chinook and Snake River fall chinook salmon as threatened (SRSRT, 1994).

Snake River sockeye salmon were listed as endangered on November 20, 1991 (56 FR 58619). Snake River spring/summer chinook and Snake River fall chinook salmon were listed as threatened on April 22, 1992 (57 FR 14653). Snake River spring/summer chinook and Snake River fall chinook were reclassified as endangered by an emergency ruling from NMFS, dated August 18, 1994 (59 FR 42529). NMFS later withdrew the proposed ruling of endangered on January 12, 1998 (63 FR 1807-01). The stocks remain threatened.

Critical habitat was designated for Snake River sockeye, spring/summer chinook, and fall chinook on December 28, 1993 (58 FR 68543).

Snake River wild steelhead (*O. mykiss*) was proposed for threatened status on August 9, 1996 (61 FR 41541), and was formally listed on August 18, 1997 (62 FR 43937).

2.3 Northwest Power Planning Council Fish and Wildlife Program Amendments

The Northwest Power Planning Council (NPPC) was authorized by the Pacific Northwest Electric Planning and Conservation Act of 1980 (16 USC 839d-1). NPPC is made up of representatives from the States of Idaho, Montana, Oregon, and Washington and is entrusted with the responsibility of finding ways to acquire and market new power sources while giving equitable treatment to fish and wildlife. In 1982, the NPPC issued a comprehensive Columbia River Basin Fish and Wildlife Program that addressed salmon and steelhead production, safe passage, and harvest management; resident fish and wildlife protection; future hydroelectric development; and coordination among Federal agencies responsible for Columbia River Basin resources.

In 1991, the NPPC began a series of amendments to the Fish and Wildlife Program to institute a regional salmon and steelhead rebuilding plan. The NPPC was responding to a request from the Northwest Governors, the congressional delegation, and NMFS to develop a comprehensive salmon plan. All three entities had expressed interest in a regionally developed plan that NMFS could use as a basis for formulating its salmon recovery plan under the ESA. Although the focus of NPPC's efforts was the petitioned stocks, NPPC also believed that the measures it adopted would help all weak stocks. The purposes of the NPPC's amendments are to preserve the ecological and genetic diversity of the runs while rebuilding their overall numbers. In its efforts to produce a comprehensive plan, the NPPC considered all measures that could benefit salmon and steelhead, regardless of who should implement those measures (NPPC, 1991).

Phase I of the amendment process, which took place during the summer of 1991, focused on emergency habitat and production actions. Phase II amendments, completed in December 1991, concentrated primarily on fish survival during migration in the mainstems of the Columbia and Snake rivers and on harvest. Phase II also introduced the concept of a framework that ties existing and future salmon rebuilding actions together into a comprehensive plan; the plan was based on stated goals and objectives, with performance standards and schedules to measure progress.

Annex B contains excerpts from the amendments.

2.4 Columbia River Salmon Flow Measures Options Analysis/Environmental Impact Statement

In May 1991, the Corps, with BPA and BOR as cooperating agencies, began preparation of the 1992 Options Analysis/Environmental Impact Statement (OA/EIS) on the effects of operational changes at certain Federal multipurpose water projects in the FCRPS. The OA/EIS was undertaken to analyze effects of proposed changes to the FCRPS in response to several actions: the November 20, 1991 listing of the Snake River sockeye salmon as endangered under the ESA; the proposed listing of several other wild salmon stocks as endangered or threatened; discussions during the Salmon Summit; and recommendations contained in the Phase II amendments of NPPC's Fish and Wildlife Program. The final OA/EIS was issued in January 1992 (Corps, 1992a).

The OA/EIS considered several alternative water management actions that could be taken in 1992 at dam and reservoir projects along the lower Snake and Columbia Rivers to improve juvenile and adult anadromous salmon migration conditions. Options considered were grouped into five general alternatives: (1) no action; (2) reservoir drawdown (including short-term tests); (3) flow augmentation; (4) combination of drawdown and flow augmentation; and (5) temperature control test. The action alternatives were designed to increase the velocity of the water, which in turn would pass the young salmon downstream faster during the April to August migration.

Several drawdown proposals were considered for all or part of the April to August migration, ranging from drawing down the reservoirs to the minimum normal operating level, to lowering the elevation of certain reservoirs to near the level of the overflow structure of the dam (spillway). The Corps identified eight options that fell within these drawdown ranges and also met operating considerations and flow velocity objectives. Six of the options applied to the lower Snake River facilities.

With flow augmentation, additional water would be released from storage reservoirs in the spring to increase the river flow during juvenile fish migration. Options considered varied with respect to the source of the water used to augment flows, the volume storage to be released, and the timing of releases. Based on computer analyses of combinations of options that provide significant increases in flow velocities, three combinations were identified as likely scenarios and were discussed in this OA/EIS. Release options were also considered to improve conditions for adult salmon migrating in the fall.

The environmental impacts of the proposed actions considered in the OA/EIS included the effects of altering normal river operations on a number of resource areas: water quality, anadromous fish, resident fish, wildlife, soils, air quality, transportation, agriculture, power, recreation, aesthetics, cultural resources, socioeconomics, and dam safety.

The preferred alternative for 1992 included: (1) drafting all four lower Snake River facilities to minimum operating pool (MOP) from April 1 to July 31; (2) conducting a drawdown test of Lower Granite and Little Goose in March; (3) operating John Day Reservoir at 80 meters (262.5 feet) (the minimum pool at which irrigation pumps will function) from May 1 through August 31, or until irrigation impacts are realized; (4) augmenting the lower Snake River flow with 111,060 hectare-meters (900 thousand acre-feet) or more from Dworkshak and variable releases to meet a target flow of 2,832 cubic meters per second (100 thousand cubic feet per second) at Lower Granite from April 15 through May 31; (5) augmenting the lower Columbia River flow up to 370,200 hectare-meters (3 million acre-feet) or less to meet target flow of 5,664 cubic meters per second (200 thousand cubic feet per second) at The Dalles from May 1 through June 30; and (6) releasing up to 44,424 hectare-meters (360 thousand acre-feet) from Dworshak in August to test temperature control options.

2.5 Reservoir Drawdown Test

As part of the 1992 Operation Plan, the Corps conducted a test drawdown at the Lower Granite and Little Goose facilities on the lower Snake River. The test was intended primarily to determine the physical effects of partial drawdown. As such, the test was scheduled to occur when few anadromous fish are present in the river. The idea behind the drawdown concept is to increase river velocities to more closely resemble natural juvenile migration conditions. In March 1992, the Corps drafted Lower Granite 11 meters (36 feet) and Little Goose 3.8 meters (12.5 feet) below the MOP levels for which they were designed. Nine spill tests were also conducted during the drawdown to determine impacts to structures, gas supersaturation levels from spilling, and potential adult passage conditions at these lower reservoir elevations.

Conclusions in the Corps' report (Corps, 1993a) on the drawdown experiment include:

- There was no major damage to dam facility structures and minor stilling basin damage.
- Turbines continued to operate safely, but efficiency decreased (potentially indicating increase in juvenile fish mortality); there was some vibration in the turbines.
- Water velocity measurements indicated that water velocities increased substantially in the upstream end of the reservoir as it returned to a free-flowing river; in the lower reservoir, drawdown effects on velocity were considerably reduced in the deeper water near the dam.
- There was an increase in dissolved gas supersaturation in the stilling basin (which may result in gas bubble trauma in fish) during spill. Dissolved gas levels as a result of spills ranged up to 135 percent, from a background of 100 to 104 percent. The supersaturation level was related to total spill discharge.
- Some roads and railroad beds were damaged and embankment sloughs occurred in various areas along the reservoir.
- Large numbers of resident fish, clams, mussels, and crayfish were lost due to receding water elevations.

The test stopped commercial barge traffic and caused some damage to floating docks; structures located adjacent to or on rivers edge, well systems, irrigation systems, and recreation areas. Exposed cultural resources were mapped and documented during the test and precautions were taken to protect exposed artifacts.

2.6 NMFS Biological Opinion on Proposed 1992 Operations of the Federal Columbia River Power System

The listing of the Snake River sockeye as endangered under the ESA required the Corps to conduct formal consultations with NMFS on any action "authorized, funded, or carried out" by the Corps to ensure that said action "is not likely to jeopardize the continued existence of any endangered species or threatened species" (Section 7 of the ESA). Such consultation would involve the preparation of a Biological Assessment (BA) on the part of the Corps, and the issuance of a biological opinion by NMFS. The BA presents the Corps' assessment of whether or not the proposed actions would jeopardize the listed species, while the biological opinion is NMFS's opinion.

Because the Snake River sockeye was listed as endangered in December 1991, consultation was added to the process of selecting the preferred river operation alternative in the 1992 OA/EIS. The consultation began on December 20, the day the ESA listing took effect. The Corps submitted a BA of actions proposed to increase velocities in Snake and Columbia River reservoirs as well as its draft Fish Passage Plan for 1992; BPA submitted a BA of the 1992 Operation of the FCRPS. NMFS reviewed this information, as well as modifications to the 1992 FCRPS Operations generated during the consultation process, and issued its required Biological Opinion on April 10; 1992 (NMFS, 1992). The Biological Opinion concluded "that the proposed operations are not likely to jeopardize the continued existence of listed or proposed salmon species." However, in its transmittal letter NMFS included the caveat that it was "concerned that if operation of FCRPS continued as is proposed for 1992, it would not be sufficient to reverse the decline over one lifecycle of the salmon; therefore, additional steps will likely be needed in 1993 and future years."

2.7 Corps Operations Plan

After NMFS issued its Biological Opinion, the Corps issued a Record of Decision (ROD) that described its Operations Plan for 1992. The following measures were included in the Operations Plan:

- Conduct a drawdown test at Lower Granite/Little Goose (addressed by a separate ROD issued in February 1992).
- Operate lower Snake River facilities near MOP April 1 to July 31.
- Operate John Day Reservoir near 80 meters (262.5 feet) elevation from May 1 to August 31, unless impacts to irrigation intakes result.
- Conduct various flow augmentation releases from Dworshak Dam during salmon migration periods.
- Release water from Grand Coulee and Arrow dams for flow augmentation from May 1 to June 30.
- Monitor and evaluate use of available water throughout the fish passage season.
- Continue release of additional water over spillways according to Spill Agreement.
- Continue fish transport.
- Continue improvements of fish passage systems.

2.8 Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Final Supplemental Environmental Impact Statement

This Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon Final Supplemental Environmental Impact Statement (SEIS) evaluated the impacts of several alternatives for operating certain dams and reservoirs on the FCRPS during 1993 and future years until a long-term plan of action could be developed (based on results of ongoing long-term studies). The SEIS was prepared by the Corps in cooperation with BPA and BOR. The proposed action was being considered in response to the ESA listing for Snake River salmon. The SEIS was issued in March 1993 (Corps, 1993b).

The SEIS examined actions similar to those evaluated in the Columbia River Salmon Flow Measures OA/EIS (Corps, 1992a), but as a recurring annual event over a longer time period. It also analyzed the impacts of such actions on projects not addressed in the OA/EIS. To conform to Council on Environmental Quality (CEQ) guidelines, the SEIS was "tiered" to the 1992 OA/EIS; this means that discussions and analyses from the OA/EIS, if there were no change, were generally summarized and incorporated by reference into the SEIS.

The SEIS addressed water management activities to be implemented in 1993 and planned for future years until the plan of action may be changed as a result of long-term studies. The actions considered in the SEIS involved some combination of measures similar to those selected in the 1992 OA/EIS and identified through consultation with NMFS under Section 7 of the ESA.

Specifically, the SEIS presented five alternatives:

1) Without project conditions, or the no-action alternative, which represent water management actions undertaken from 1985 through 1990
2) A 1992 operation alternative excluding the March drawdown test of Lower Granite and Little Goose
3) The 1992 operation alternative (without the March drawdown test) modeled to display potential impacts to Libby and Hungry Horse under different operating assumptions
4) A modified 1992 operation alternative (without the March test drawdown), including improvement to salmon flows from Dworshak
5) The modified 1992 operation alternative (without the March test drawdown), modeled to show water from the upper Snake.

As with the 1992 OA/EIS, the environmental impacts of the proposed actions considered in this SEIS included the effects of altering normal river operations on a number of resource areas: water quality, anadromous fish, resident fish, wildlife, soils, air quality, transportation, agriculture, power, recreation, aesthetics, cultural resources, socioeconomics, and project structures.

The fourth alternative, involving modifications to the 1992 operating plan, was identified as the preferred alternative. It was selected on the basis of salmon survival effects, cost effectiveness, environmental effects, and the scope of existing authorities.

2.9 NMFS Biological Opinion on Proposed 1993 Operations of the FCRPS

On May 26, 1993, NMFS issued its Biological Opinion for 1993 operations of the FCRPS (NMFS, 1993). This Biological Opinion was based on a number of documents provided by the Corps, including the SEIS, as well as modifications to the 1993 Operations Plan developed during the intense consultation process. In the cover letter to the Biological Opinion, the NMFS Acting Assistant Administrator for Fisheries stated:

> *Operation of the FCRPS is a major factor in the decline of listed Snake River salmon. However, NMFS has determined that flow augmentation measures, adopted by the Federal agencies in the May 12, 1993 letter, and other measures including, spill improvement in structures and fish bypass facilities, and monitoring activities have reduced the anticipated mortality of listed Snake River salmon adequately for the purposes of the 1993 consultations to a level that is not likely to jeopardize the continued existence of the listed species. The Recovery Plan is expected to identify long-term, comprehensive, planning actions that will initiate the recovery of the listed Snake River salmon. Guidelines established by the Recovery Plan will be the basis for NMFS Section 7 consultations when the Plan is final.*

2.10 NMFS Biological Opinion on Proposed 1994-1999 Operation of the FCRPS and Juvenile Transportation Program in 1994-1998

This consultation concerned operations of the FCRPS from 1994 through January 31, 1999. NMFS considered a plan of actions for the FCRPS that the action agencies (Corps, BPA, BOR) proposed on December 2, 1993 in their BA and in revisions submitted in January 1994. NMFS issued its Biological Opinion on March 16, 1994 (NMFS, 1994). The Biological Opinion and the action agencies' RODs concluded that the proposed operation of the FCRPS was not likely to jeopardize the continued existence of the endangered or then threatened Snake River salmon species. The Biological Opinion included an incidental take statement pursuant to Section 7(a)(4) of the ESA which required that the action agencies comply with certain reasonable and prudent measure, terms, and conditions intended to further avoid and minimize take of listed salmon.

2.11 Law Suit and Court Decision (*Idaho Department of Fish and Game v. National Marine Fisheries Service*)

At the same time the 1994 consultation was in progress, the Idaho Department of Fish and Game (IDFG), the State of Oregon, and four treaty tribes challenged the legal adequacy of NMFS' 1993 Biological Opinion for FCRPS Operations in Federal district court proceedings (*Idaho Department of Fish and Game v. National Marine Fisheries Service*, Civ. No. 92-973-MA (Lead Case), 93-1420-MA, 93-1603-MA, (D. Or.) (*IDFG v. NMFS*). In a judgment entered on April 28, 1994, the Court ordered on page 4 that:

> *IT IS FURTHER ORDERED AND ADJUDGED that the Biological Opinion on 1993 Federal Columbia River Power System operations prepared by the National Marine Fisheries Service, and the Records of Decision prepared by the Corps of Engineers and Bureau of Reclamation in reliance upon said biological opinion, for*

the reasons stated in this court's opinion of March 28, 1994, are arbitrary and capricious and otherwise not in accordance with the purposes of the Endangered Species Act, Section 7(a)(4), with respect to the chosen jeopardy standard and their consideration of reasonable and prudent alternatives to avoid jeopardy. That the 1993 biological opinion and records of decision are set aside and remanded to review and reconsider them, or at their option, to review and reconsider the 1994-98 hydropower biological opinion, in light of the (sic) court's order of March 28, 1994, and to submit a biological opinion and records of decision to address that ruling by June 27, 1994, unless that date is extended by further order of this court.

NMFS and the action agencies, the defendants in this lawsuit, opted to reconsider the newly issued 1994-1998 FCRPS Biological Opinion rather than expend limited resources reconsidering the challenged 1993 opinion about FCRPS actions that were then completed. The Federal agencies further decided to work cooperatively with all the other parties, and particularly with the states and treaty tribes, rather than appealing the judgment and continuing to litigate the issues raised in the case.

From May 9, 1994, through November 30, 1994, NMFS and the action agencies (the Corps and BOR) participated in a series of discussions and working groups with the parties to this litigation. The purpose of these discussions was to better facilitate the collection and consideration of credible and relevant scientific evidence in a re-evaluation of the application of the standards of ESA Section 7(a)(2) to the FCRPS and of alternatives and measures for FCRPS operation and facilities. The Federal agencies and other parties to the litigation were aided by technical assistance provided through interagency working groups of technical personnel; one to consider the biological requirements of the listed species and the other to inventory and evaluate alternative actions and measures for the FCRPS.

The Court extended the original deadline established by the Judgment directing the issuance of a new Biological Opinion by January 30, 1995 (*IDFG v. NMFS*, Civil Minutes, Record of Order dated October 18, 1994: Granting Federal defendants October 8, 1994, request for extension of time as set forth in the schedule attached to William Stelle, Jr.'s affidavit). The Court granted further extensions in this deadline until March 1, 1995.

2.12 Snake River Salmon Recovery Team's Final Recommendations to the National Marine Fisheries Service

Following the listing of Snake River sockeye salmon as an endangered species, NMFS appointed the SRSRT to independently develop recommendations for a Recovery Plan for the species (as required under Section 4(f) of the ESA). Upon subsequent listings of Snake River spring/summer and fall chinook salmon as threatened species, SRSRT's responsibilities were expanded to include these fish as well (SRSRT, 1994).

The SRSRT developed draft recovery plan recommendations over the course of 27 months by compiling available information through an open public process. The SRSRT visited areas in the range (past and present distribution) of listed Snake River salmon and sought scientific, cultural, and economic expertise from parties throughout the region (SRSRT, 1994).

On October 20 1993, the SRSRT released draft recovery plan recommendations and solicited peer review to ensure that the factual materials were correct and that their analysis and interpretations

were scientifically sound. SRSRT revised their recommendations based on comments received, updated information, and new analyses, and issued their final recommendations in May 1994.

2.13 Lower Snake River Biological Drawdown Test Draft Environmental Impact Statement

The Corps and NMFS as joint lead agencies, along with the BPA as a cooperating agency, analyzed four general alternatives intended to provide information on the biological effects of reservoir drawdown on migrating juvenile salmon and steelhead. The test would also provide an opportunity to study the effects of reservoir drawdown on adult salmonids, resident fish, wildlife, and other components of the lower Snake River ecosystem. These four alternatives included Alternative 1, No Action, and three different ways to conduct a biological drawdown test at Lower Granite Reservoir on the lower Snake River in Washington State. These action alternatives were: Alternative 2, using sanctuary dipnets or gatewell baskets to remove fish guided to the gatewell slots at the dam; Alternative 3, using a new gatewell tank removal system to bypass juvenile fish entering the powerhouse; and Alternative 4, using a new lower-level bypass system to divert fish entering the powerhouse. The alternatives could have been implemented with the project spillway or the powerhouse as the primary route of downstream passage. The action alternatives had multiple options for spring, summer, or spring-summer test durations. The drawdown test could have been done for only one migration season, or could be repeated for up to 4 years. The preferred alternative of the agencies was Option 3A, a 2-month drawdown of Lower Granite Reservoir in spring 1996. However, findings from ongoing studies and data collection by scientists of the NMFS and the University of Washington School of Fisheries Center for Quantitative Science indicated that juvenile salmon migrating through Lower Granite Reservoir experienced a much higher survival rate than originally thought—in excess of 90 percent. Because juvenile salmon survival was shown to be already high through the reservoir, it was determined to be likely that there would be insufficient change resulting from a drawdown test at Lower Granite to make meaningful statistical inferences. Because of this, the drawdown test was never implemented, and no final EIS was prepared.

2.14 NMFS Biological Opinion on Reinitiation of Section 7 Consultation on Proposed 1994-1998 Operation of the FCRPS and Juvenile Transportation Program in 1995 and Future Years

With the conclusion of the 1994 lawsuit and associated post-judgment discussions, this consultation was formally reinitiated by the action agencies on December 15, 1994. In a letter to NMFS transmitting the *Supplemental Biological Assessment on Federal Columbia River Power Operations*, the action agencies identified the proposed action under consideration to be the 1994 to 1998 operations proposed in the previous consultation while at the same time considering longer-term changes in operations and structures such as those identified in their System Operations Review (SOR).

On March 2, 1995, NMFS issued its Biological Opinion (NMFS, 1995a). The Biological Opinion concluded that "the operation of the FCRPS as described in the 1994-98 Biological Opinion is likely to jeopardize the continued existence of listed" salmon stocks (spring/summer chinook, fall chinook, sockeye). The Biological Opinion also concluded that "the only way to achieve significant improvements is with long term system reconfigurations."

The Biological Opinion included a "Reasonable and Prudent Alternative to the Proposed Action" (alternative) which identifies "immediate, intermediate and long term actions that will improve the operation and configuration of the hydropower system" and will lead to reduced mortality of the listed fish. The Biological Opinion states the following:

> *The alternative employs an adaptive approach to increasing survival and the probability of recovery of listed salmon, by taking immediate actions to improve mainstem survival while reducing the uncertainty about the likely benefits of, need for and feasibility of major system structural modifications. Immediate survival improvements include improved bypasses, increased spills and spring/summer flows, reduced fish handling, better fish transportation conditions, etc. Major structural modifications include installation of surface collectors and drawdowns (natural river or spillway crest).*

The alternative identified six immediate planning and evaluation efforts to address potential system modifications, including "complete necessary planning tasks to begin implementation of drawdown." The alternative also specified a formal decision path for the implementation of long-term alternatives (Corps, 1996); the path has two major decision points. The first was in 1996, when the Corps was to have completed an interim evaluation report and preliminary decision regarding the selection of one of three drawdown alternatives (seasonal, near spillway crest drawdown; seasonal, near natural river drawdown; permanent, near natural river drawdown) and surface collectors (Corps, 1996). If a decision on drawdown could not be made in 1996, a second decision point was identified in 1999 (Corps, 1996). At that time, a final plan for drawdown or surface bypass collection would be selected, and feasibility evaluations and National Environmental Policy Act (NEPA) documentation would be completed (Corps, 1996).

2.15 Issuance of Corps' Record of Decision on Operations Plan for 1995 and Future Years

On March 10, 1995, the Corps issued its ROD on proposed operations of the FCRPS for 1995 and future years. The ROD documented the Corps' intent to fulfill the recommended measures in the NMFS Biological Opinion in an expeditious and responsive manner.

2.16 A Proposed Recovery Plan for Snake River Salmon

In March 1995, NMFS published a *Proposed Recovery Plan for Snake River Salmon,* which aimed "to restore the health of the Columbia and Snake River ecosystem and to recover listed Salmon River stocks" (NMFS, 1995b). The proposed recovery plan was developed from recommendations made by the SRSRT in its May 1994 report to NMFS (SRSRT, 1994). The Recovery Plan includes the following:

> *The conservation of natural salmon and their habitat has not been afforded balanced consideration in past resource allocation decisions. Natural salmon are those that are the progeny of naturally spawning parents. Development in the Pacific Northwest has often proceeded with the assumption that improved technology or management would mitigate impacts on natural salmon stocks. The Region's reliance on uncertain mitigation schemes (as opposed to fundamental conservation strategies) has been a very costly approach, both for natural salmon and the public.*

However, recent efforts have concentrated on conserving natural salmon and their habitats. There is new emphasis being placed on natural fish escapement, improved migration conditions for juveniles and adults, increased riparian area protection, and equitable consideration of natural fish in resource allocation processes. This focus differs from previous management and represents important progress toward recovering listed Snake River salmon, restoring Columbia Basin ecosystem health, and benefiting other species presently in serious decline.

Annex A contains a summary of Proposed Recovery Plan provisions related to mainstem survival of the listed salmon.

2.17 Final Environmental Impact Statement for Columbia River System Operation Review (SOR)

The Columbia River SOR, a joint effort of the Corps, BPA, and BOR, was initiated on July 18, 1990 to review multipurpose management of the Columbia-Snake River System and provide a strategy for system operation. SOR started as a comprehensive, long-term study to review system operations of Federal water resource projects on the Columbia River and its tributaries in view of present and future needs of all users. The study included a technical, social, economic, and environmental analysis of alternatives for operation of the FCRPS, and an environmental analysis needed for Federal agencies to renew the Pacific Northwest Coordination Agreement (PNCA). The scope of the review included 14 major Federal projects on the Columbia River and its tributaries (12 operated by the Corps, 2 operated by BOR).

With the ESA listings of Snake River sockeye and chinook stocks in 1991 and 1992, the SOR took on a different character. It began to focus on the role that system operations could play in salmon recovery and NMFS became a key player (because of its responsibility under the ESA for determining the biological consequences of river operations).

Work on the SOR was conducted by ten functional work groups and four analysis groups. The functional work groups evaluated the impacts of system operation alternatives under consideration for the particular functional area represented by each work group. For example, the anadromous fish work group evaluated the alternatives to determine impacts on anadromous fish, and the water quality work group focused on water quality. Representation on each of the work groups included staff from each of the three lead Federal agencies, in addition to the states, other Federal agencies, utility and other interest groups, the tribes, and the general public.

The analysis groups examined the alternatives from a broader perspective. The River Operation Simulation Experts used computer models to determine flows and evaluations for each of the 90 alternatives for further evaluation of impacts by the technical work groups. The Economics Group analyzed direct and indirect economic impacts of the alternatives during full-scale analysis. The NEPA group guided preparation of the draft and final EIS to document all aspects of the review. The fourth group, PNCA Alternatives, was concerned with alternative forms of coordination for power.

The Draft EIS for SOR was issued in July 1994. It contained seven alternative System Operating Strategies (SOS):

SOS 1: Pre-ESA Operation—base case strategy without various measures resulting from ESA listings of anadromous fish; operations directed at power production and flood control satisfies traditional nonpower requirements at projects.

SOS 2: Current Operations—current system operations, including efforts to provide additional anadromous fish flows; flow augmentation of up to 370,200 hectare-meters (3 million acre-feet), in addition to the Water Budget; supplemental drafts from Dworshak Reservoir; flood control space shifted from the Snake River Basin to Grand Coulee Dam; lower Snake River projects near minimum operating pool levels; John Day at minimum irrigation pool level.

SOS 3: (DELETED)

SOS 4: Stable Storage Project Operation—year-round monthly elevation targets at storage projects; operations based on integrated rule curves at Libby and Hungry Horse Dams.

SOS 5: Natural River Operation—lower Snake drawdowns to natural river level; flow augmentation of up to 370,200 hectare-meters (3 million acre-feet) and Water Budget from mid-Columbia River; John Day at minimum operating pool during spring and summer; Dworshak at flood control levels.

SOS 6: Fixed Drawdown—lower Snake drawdown to spillway crest level; flow augmentation of up to 370,200 hectare-meters (3 million acre-feet) and Water Budget from mid-Columbia River; John Day at minimum operating pool during spring and summer; Dworshak at flood control levels.

SOS 7: Federal Resource Agency Operations—REPLACED WITH NEW ALTERNATIVES.

While the SOR agencies were finishing the Draft EIS in spring 1994, the U.S. District Court issued its ruling in *IDFG vs. NMFS* that the 1993 Biological Opinion had failed to meet the necessary legal standard. A key issue in this lawsuit was whether enough water in the Columbia River System had been dedicated to salmon recovery and whether the new Biological Opinion must incorporate more water for fish into operations. Shortly after the *IDFG vs. NMFS* ruling, the 9th Circuit Court of Appeals issued a ruling in another case, which said that the Northwest Power Planning Council (NPPC) had not given proper consideration to the recommendations of state resource agencies and tribes in preparing its Fish and Wildlife Program. Many people interpreted this decision to mean that state agency and tribal proposals should be given more weight in the operating decision. It became clear to the Federal operating agencies that the SOS that came out of SOR would need to take these legal decisions into account. In March 1995, NMFS issued its Biological Opinion on hydrosystem operations. Two additional decisions in lawsuits pertaining to fish operations were issued in June 1995; these decisions recognized the 1995 Biological Opinion as the guideline for operating the hydrosystem in light of the ESA.

From these events and activities, the alternatives for the Final EIS evolved. Those alternatives, as modified from the Draft EIS, were:

SOS 1a: Pre-Salmon Summit Operation—represents operations as they existed from 1983 to 1991 and includes the original Water Budget.

SOS 1b: Optimum Load-Following Operation—represents operations as they existed prior to changes resulting from the Northwest Power Act.

SOS 2c: Current Operations/No Action—represents an operation consistent with the Corp's 1993 Supplemental EIS; it includes up to 52,700 hectare-meters (427 thousand acre-feet) of additional water from above Brownlee Dam to improve fish flows.

SOS 2d: 1994-98 Biological Opinion (NEW)—matches the hydro operations contained in the 1994-98 Biological Opinion issued by NMFS in mid-1994.

SOS 3: (DELETED)

SOS 4c: Stable Storage Project Operation (REVISED)—applies integrated rule curves developed by Montana at Libby and Hungry Horse year-round; Dworshak and Albeni Falls are operated to specific elevations; Grand Coulee is also operated to specific elevations to provide acceptable water retention times; Grand Coulee flood central rule curves are applied only when the January-July forecast is greater than 8,400,000 hectare-meters (68 million acre-feet).

SOS 5b: Natural River Operation—draws down the lower Snake River facilities from April 16 through August 31 each year.

SOS 5c: Permanent Natural River Operation (NEW)—assumes the drawdown occurs year-round with no refill of the facilities to normal operating ranges.

SOS 6b: Fixed Drawdown Operation—draws down all four lower Snake River facilities for four and one-half months.

SOS 6d: Lower Granite Drawdown Operation—draws down only Lower Granite facility for four and one-half months.

SOS 7: (REPLACED WITH NEW ALTERNATIVES)

SOS 9a: Detailed Fishery Operating Plan—establishes flow targets at The Dalles, based on the previous year's end-of-year storage content; specific volumes of water are released from Dworshak and Brownlee, and lower Snake River facilities are drawn down to near spillway crest level for four and one-half months; specific spill percentages are established at run-of-river projects; spill caps are used to prevent excessive total dissolved gas; fish transportation is assumed to be eliminated.

SOS 9b: Adaptive Management—establishes fixed flow targets at McNary and Lower Granite dams from April through July.

SOS 9c: Balanced Impacts Operation—establishes higher fixed flow targets, compared to SOS9b, at McNary and Lower Granite dams.

SOS PA: Preferred Alternative (NEW)—spring and summer flow targets for the Snake and Columbia rivers; refill to flood control levels by early spring; summer draft limits at storage reservoirs; Kootenai River white sturgeon operation; drawdown to minimum operating pool levels; increased spill levels limited by dissolved gas.

A final EIS for the SOR was completed in November 1995 (BPA 1995). The Preferred Alternative included the following provisions:

- Spring and summer flow targets for the Snake and Columbia rivers
- Refill to flood control levels by early spring

- Summer draft limits at storage reservoirs
- Kootenai River white sturgeon operation
- Drawdown to minimum operating pool levels
- Increased spill levels limited by dissolved gas.

The Corps signed the SOR ROD selecting the Preferred Alternative in February 1997.

2.18 Independent Scientific Group Review of NPPC's Fish and Wildlife Program

In the December 1994 amendments to the Columbia River Basin Fish and Wildlife Program, the NPPC called on the BPA to fund the Independent Scientific Group (ISG) to conduct a biennial review of the science underlying salmon and steelhead recovery efforts and Columbia River Basin ecosystem health. The NPPC's objective was to provide the region, to the greatest extent possible, clear analysis conducted by impartial experts.

The NPPC also asked that the ISG develop a conceptual foundation for the fish and wildlife program, to provide an overall set of scientific principles and assumptions on which the program and fish and wildlife management activities basinwide could be based and against which they could be evaluated. On September 18, 1996, the ISG delivered its report *Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem* to the NPPC (ISG, 1996). The report contains the first biennial review and a proposed conceptual foundation for the Fish and Wildlife Program. After an introductory chapter, the report is divided into four main components: Chapter 2 contains the proposed conceptual foundation for the Fish and Wildlife Program; Chapter 3 contains the review of scientific basis for measures included in the current Fish and Wildlife Program, using the conceptual foundation as a template for this evaluation; Chapters 4 through 10 contain the detailed technical data and documentation on which Chapters 2 and 3 are based; Chapter 11 describes general conclusions from the ISG review.

In submitting its report, the ISG expressed the hope that the report will be a valuable resource for decisionmakers. The findings should enable fishery managers to focus future research activities on areas that still are not thoroughly understood. However, the review does not include policy recommendations for recovery and restoration. Nor does it recommend specific measures or strategies or deal with institutional structures. It is not an implementation plan. Instead, the conceptual foundation proposed in the report should provide the scientific foundation for public policy to be developed by the NPPC and other decisionmaking bodies. It can be used to guide salmon restoration activities in general, as well as future development of the Columbia River Basin Fish and Wildlife Program.

Annex B contains excerpts from the ISG Report (1996).

2.19 Memorandum of Agreement for BPA Funding (System Configuration Team)

On September 16, 1996, five federal agencies involved in salmon and other fish and wildlife restoration activities in the Columbia River Basin signed a Memorandum of Agreement (MOA) to maintain BPA funding for Columbia Basin fish and wildlife activities at an average of $435 million per year for fiscal years 1996 through 2001. Regional efforts to rebuild fish and wildlife resources

affected by development of the hydropower system have been funded by several sources, including BPA rate payers and various Corps appropriations. The MOA represents an effort to balance the dramatically escalating costs of fish and wildlife restoration with the need to provide BPA with a degree of financial stability in a competitive energy market. Signers of the MOA represented the Department of the Army (for the Corps), the Department of Energy (for BPA), the Department of Interior (for USFWS and BOR) and the Commerce Department (for NMFS).

2.20 System Configuration Study

The System Configuration Study (SCS) was initiated by the Corps in 1991 to evaluate the technical, environmental, and economic effects of potential modifications to the configuration of Federal dams and reservoirs on the Snake and Columbia rivers with the goal of improving survival rates for anadromous salmonids migrating downriver (Corps, 1996). The SCS evolved in response to the NPPC's *Fish and Wildlife Program Amendments (Phase Two)* issued in December 1991 (Corps, 1996).

The SCS has been conducted in two separate phases (Corps, 1996). Phase I, a reconnaissance-level assessment of multiple concepts, including drawdown, upstream collection, additional reservoir storage, a migratory canal, and several other alternatives, was completed in June 1995 (Corps, 1996). Phase II is a detailed assessment of the alternatives that emerged from Phase I as holding the greatest potential benefit for anadromous salmonids (Corps, 1996).

2.20.1 SCS Phase I

Alternatives examined under Phase I, a reconnaissance-level screening of alternatives, included: 1) changes to existing facilities to improve passage and survival rates of juveniles and adults; 2) the possible addition of upstream water storage sites to be used for river flow and temperature modifications (the BOR is leading an interagency assessment of potential new dam sites); 3) annual drawdowns of four lower Snake and the John Day (lower Columbia) reservoirs to various levels during juvenile migration periods; and 4) the addition of new facilities, upstream of Lower Granite Dam, to collect juveniles and divert them onto a barge or into a migratory canal along the river, or a floating or underwater pressurized pipeline (in conjunction with Alternative 4).

The Corps initially had 22 options under Alternative 3 (above) pertaining to possible drawdowns of lower Snake facilities (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor). The initial screening, based on engineering feasibility, biological effectiveness [a Technical Advisory Group (TAG) assessed the biological impacts and effectiveness of alternatives being considered under Phase I; the TAG included representatives from the Corps and other Federal and state agencies, interest groups, and the biological community], and acceptability, eliminated 12 options. Additional screening narrowed the list to three drawdown options to be considered in greater detail in Phase II: 1) seasonal, near spillway crest drawdown; 2) seasonal, near natural river drawdown; and 3) permanent, near natural river drawdown.

2.20.2 SCS Phase II

SCS Phase II has developed into a major program containing many separate and specific studies (Corps, 1996). The Lower Snake River Juvenile Salmon Migration Feasibility Study is part of SCS Phase II, and is considered separately in the following section. This growth in the scope of Phase II

was considered necessary to adequately and efficiently respond to the requirements for multiple evaluations addressed in the NMFS 1995 Biological Opinion.

2.21 Lower Snake River Juvenile Salmon Migration Feasibility Study

The current study is one of several studies under Phase II of the SCS. It was initiated in 1994 to evaluate the technical, environmental, social, and economic effects of potential modifications to the configuration of four projects on the lower Snake River in order to increase the survival of juvenile anadromous fish as they migrate through the project areas, as directed by the NMFS 1995 Biological Opinion.

The current study includes engineering work; biological investigation (i.e., effects to salmon and steelhead, resident fish, and wildlife); effects on recreation, cultural resources, and water quality; and socioeconomic effects, including implementation costs, navigation, irrigation, and power. Also included is the development of an EIS and public involvement, both of which are essential to the NEPA process.

The initial pathways being evaluated in the study included: 1) the existing system, 2) major system improvements, and 3) natural river drawdown.

In an Interim Status Report issued in December 1996 (as directed by the NMFS 1995 Biological Opinion), the Corps stated the following:

> *Findings, based on the consideration of all data, indicate that there is insufficient information at this time for the Corps to make a recommendation on the best configuration of the hydropower system to safely pass juvenile salmon in the lower Snake River. However, preliminary conclusions on the drawdown options indicate that seasonal spillway crest and seasonal natural river should be eliminated from further consideration. Consequently, the Corps recommends the continuing investigation of three courses of action to improve salmon migration: permanent drawdown to natural river, surface bypass/collection, and the current fish programs, as well as combinations of the three.*

These, then, are the alternatives under evaluation:

1. Existing System—under current operations, as directed by the 1995 Biological Opinion, ocean-going juvenile salmon pass the dams through turbines, fish bypass systems, or over the spillways. In accordance with the Biological Opinion issued by the NMFS, the Corps also implements flow augmentation and increased spill measures to assist migration. Screens are used to guide most fish away from turbines and into a bypass system. The young salmon are then routed back to the river or to a holding area for transport downriver by barge or truck. This system is constantly being evaluated and improved by scientists and engineers. Ongoing improvements include longer screens, additional barges, and flow deflectors on spillways.

2. Major System Improvements—These improvements would include construction of surface bypass collection systems (fish bypass systems that divert fish beginning at a more shallow level than current systems), fish guidance improvements, turbine modifications, structural changes to reduce harmful dissolved gas levels, and possible operational changes such as

modifying river flows and spills. This could include improvements to the juvenile fish transportation system or in-river juvenile migration.

3. Natural River Drawdown—Existing reservoirs would be permanently lowered to a natural free-flowing condition by removing a section of each dam, creating a 225-kilometer (140-mile) free-flowing river. This would eliminate existing reservoir-related and dam passage mortality as well as speed the downriver migration of juvenile salmon. Commercial navigation and hydropower production would cease. Irrigation and recreation opportunities would be affected.

2.22 Process for Analyzing and Testing Hypotheses (PATH)

In 1993, fishery modelers from NMFS, BPA, NPPC, the Corps, Washington, Oregon, Idaho, and the Columbia River Inter Tribal Fish Commission formed the Analytical Coordination Work Group (ANCOOR). The objective of this work group is to compare and enhance smolt passage survival and lifecycle models used within the region for salmon management evaluation. Previous model comparison and peer-review efforts demonstrated that each smolt passage survival and lifecycle modeling system has differences in basic assumptions regarding the effects of recent and potential management actions. In 1994, a Scientific Review Panel was convened to provide technical oversight to ANCOOR. The Panel concluded that there were three major differences between the modeling systems:

- The distribution of survival over the life span
- The effect of flow on survival
- The benefit of smolt transportation.

The panel believed that as long as these differences exist, the models would output different answers in a predictable manner, rendering further analysis of model structure, behavior, and usefulness a relatively unproductive activity. The panel recommended focusing on describing and resolving the fundamental divergences through hypothesis testing. This hypothesis testing process became the Process for Analyzing and Testing Hypotheses (PATH).

2.22.1 Objectives

- Determine the level of support for key hypotheses based on existing information, and provide guidance to management agencies on the implications of these analyses for key management decisions (retrospective analyses). Propose other hypotheses and/or model improvement that are more consistent with the data.
- Assess the effects of alternative future management actions on salmon stocks, and the ability to distinguish among competing hypotheses from future information (prospective analyses). Advise various institutions (i.e., NMFS, NPPC, BPA, USFWS) on the consequences of alternative future management actions for salmon stocks, and the types of research, monitoring, and adaptive management experiments that could maximize the rate of learning and clarify decisions.

2.22.2 Process

Iteration within the PATH process occurs as this logical framework is revised over time in response to improvements in both information and analytical methods, as well as changing management questions. The framework is intended to provide guidance to the development of regional programs that would stabilize, ensure persistence, and eventually restore depressed salmon stocks to self-sustaining levels. It is also meant to provide a structure for an adaptive learning approach to development and implementation of a regional salmonid recovery program. The PATH process takes a whole lifecycle approach to developing this framework to encompass potential delayed effects of stressors or processes in one life stage on subsequent life stages.

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4. Glossary

Anadromous fish: Fish, such as salmon or steelhead trout, that hatch in fresh water, migrate to and mature in the ocean, and return to fresh water as adults to spawn.

Biological Opinion: A formal opinion/evaluation issued by a federal or state agency responsible for monitoring endangered or threatened wildlife. A preliminary assessment is often issued in response to an intra-agency request for information regarding species status and is designed to be incorporated into a biological opinion.

Bypass system channel: Fish diverted from turbine passage are directed through a bypass channel to a holding area for release or loading onto juvenile fish transportation barges or trucks.

Collection channel: Holding area within the powerhouse that fish enter after exiting the bulkhead slot.

Dissolved gas supersaturation: Caused when water passing through a dam's spillway carries trapped air deep into the waters of the plunge pool, increasing pressure and causing the air to dissolve into the water. Deep in the pool, the water is "supersaturated" with dissolved gas compared to the conditions at the water's surface.

Drawdown: In the context of this FR/EIS, drawdown means returning the lower Snake River to its natural, free-flowing condition via dam breaching.

Endangered species: A native species found by the Secretary of the Interior to be threatened with extinction.

Gatewell basket: A mechanical dipping basket used to remove fish from powerhouse gatewells.

Minimum operating pool (MOP): The bottom one foot of the operating range for each reservoir. The reservoirs normally have a 3-foot to 5-foot operating range.

Record of decision (ROD): A document, based on information disclosed in the Final Environmental Impact Statement, that identifies the alternative chosen, mitigation and monitoring measures to be implemented, and other information relative to the decision.

Resident fish: Fish species that reside in fresh water throughout their lifecycle.

Sanctuary dipnet: Another term for sanctuary bag, a 50-pound bag placed on the bottom of a gatewell basket. It retains fish placed in gatewell baskets pending their release into a tank truck.

Spill: Water released through the dam spillways, rather than through the turbines. Involuntary spill occurs when reservoirs are full and flows exceed the capacity of the powerhouse or power output needs. Voluntary spill is one method used to pass juvenile fish without danger of turbine passage.

Spillway flow deflectors (flip lips): Structures that limit the plunge depth of water over the dam spillway, producing a less forceful, more horizontal spill. These structures reduce the amount of dissolved gas trapped in the spilled water.

Stilling basin: A concrete-lined pool below a dam. Water passing through spillways generates tremendous energy that must be dissipated. This is accomplished by allowing the water to fall over the spillway into the stilling basin.

Surface bypass collection (SBC) system: System designed to divert fish at the surface before they have to dive and encounter the existing turbine intake screens. SBCs direct the juvenile fish into the forebay, where they are passed downstream either through the dam spillway or via the juvenile fish transportation system of barges and trucks.

Threatened species: A native species likely to become endangered within the foreseeable future.

Annex A

Summary of Proposed Snake River Salmon Recovery Plan Provisions Related to Mainstem Survival

(Source: NMFS, 1995b)

Note: The following is reproduced directly from the Proposed Recovery Plan for Snake River Salmon (NMFS 1995b)

Summary of Proposed Recovery Plan Provisions Related to Mainstem Survival

The goal of the Proposed Recovery Plan is to restore the health of the Columbia and Snake River ecosystem and to recover listed Snake River salmon stocks. Many of the recommended actions will directly benefit other species such as other salmon stocks, sturgeon, and bull trout. Implementation of the Proposed Recovery Plan should also conserve biodiversity, a factor that is essential to ecosystem integrity and stability. Many of the actions in the Proposed Recovery Plan have been used to formulate reasonable and prudent measures in current Section 7 consultations.

The Proposed Recovery Plan discusses the natural history and current status of Snake River salmon. It also addresses known and potential human impacts, and displays the costs directly attributable to recovery. In addition, the Proposed Recovery Plan identifies delisting criteria and biological objectives, and proposes the tasks required to meet them. Tasks are identified in the areas of institutional structure, tributary ecosystem, mainstem and estuarine ecosystem, harvest management, and artificial propagation.

NMFS' approach to Snake River salmon recovery places highest priority on ameliorating the primary factors for the species' decline and eliminating existing impediments to recovery. The Plan does this by proposing actions that offer immediate benefits, and refining those actions over time to ensure the most efficient use of limited resources. This strategy incorporates an adaptive management process; it allows actions to be added, deleted, or refined as important scientific information and analyses becomes available.

Mainstem Ecosystem

In the mainstem ecosystem, salmon face problems associated with their downstream and upstream migrations. The journey through the lower Snake and Columbia Rivers has become more hazardous since eight hydroelectric dams were built and their reservoirs created. Each dam delays juvenile fish in their transition to the ocean environment and exacts additional losses. Seventy percent of the 482 miles between the mouth of the Columbia River and Lewiston/Clarkston on the Snake River has been converted from free-flowing river into reservoirs. This change has slowed the rate of downstream travel for smolts and increased the amount of habitat favorable to predator species. Hatchery fish and exotic species compete with and prey on the listed salmon in the mainstem ecosystem.

NMFS examined various approaches to improving the downstream survival of juvenile Snake River salmon (as well as that of other fish that migrate through the corridor). The actions considered include improving in-river and dam passage conditions, improving collection and transportation systems for juvenile migrants (especially under adverse river conditions), and drawing down reservoirs.

NMFS proposes to proceed on a long-term adaptive management approach that will depend upon a combination of improved in-river migration conditions, improved transportation, and major structural changes at dams. The Proposed Recovery Plan recommends a major decision point when

sufficient adult survival information is available in 1999. In the interim, all necessary studies, planning, design, and environmental documentation for drawdowns should be completed. At the same time, in-river migration conditions should be improved to the maximum extent possible using techniques such as increased flows, increased spill, physical improvement of the dams, and aggressive surface bypass development and testing. Significant improvements should also be made in transportation operations. The overall approach is to proceed on a path that implements measures in the short term that are most likely to increase survival while at the same time enhancing our ability to isolate and address major causes of mortality in the future. Ultimately, the purpose of this approach is to determine whether there can be sufficient improvements to in-river survival and transportation to recover listed fish without major drawdowns. The listed and unlisted fish also need improvements in their upstream passage conditions. To accomplish this, the Proposed Recovery Plan prescribes actions such as installing extended length screens, operating turbines at peak efficiency for fish passage, extending the period during which the juvenile bypass system is in operation, implementing a dissolved gas abatement program, remedying water pollution problems, developing emergency auxiliary water supplies for adult fishways, and decreasing water temperatures.

Annex B

NPPC Fish and Wildlife Program

Details of Phase II Amendments Related to Mainstem Survival

(Source: NPPC, 1991)

Keypoints of ISG Report

(Source: ISG, 1996)

Note: This excerpt is reproduced directly from the Amendments to the Columbia River Basin Fish and Wildlife Program (Phase II) (NPPC 1991).

Details of Phase II Amendments Related to Mainstem Survival

Because of their focus on fish survival during migration in the mainstems of the Columbia and Snake Rivers, Phase II amendments have been of key concern to Federal agencies with management responsibility for dams on these rivers (Corps, BPA, BOR). Following are highlights of key measures in Phase II that relate to mainstem survival in the Columbia River basin, with an emphasis on the lower Snake River.

Mainstem Survival

Salmon and steelhead migrate to and from the sea, and their safe passage is critical. Several factors affect passage. Dams present physical barriers; the slower water in reservoirs impedes travel time; and the fish encounter predators. NPPC adopted the measure below to address these problems for both juvenile fish migrating downstream and adult fish moving back upstream. To enhance river operations, the NPPC established a Fish Operations Executive Committee made up of senior management representatives of NPPC, fishery managers and river operators to meet annually to develop an Implementation Plan that will be carried out by the Fish Passage Center. The Plan will address flows, spill, transportation, other agency plans, coordinated system operations, research and monitoring efforts and other mainstem passage matters. The following measures are designed to increase survival for salmon migrating in the rivers and for fish transported in barges.

Screens and bypass system at dams

- Completion of screens and juvenile bypass systems at all eight federal dams on the mainstem of the Columbia and Snake Rivers by 1998.
- Installation of longer screens to guide more fish away from turbines and evaluation of modifications that may be needed to accommodate reservoir drawdown measures.
- Expedited improvements at Bonneville Dam's second powerhouse, where screens have performed poorly since the powerhouse began operation in 1983. Also, expedited evaluation of fish guidance problems at Bonneville Dam's first powerhouse.

Reduction of predation

- Design and operation of bypass system outfalls to reduce predation by both fish and birds, as well as continued exploration of new fish bypass technologies.
- A 20 percent reduction of the squawfish population annually.
- Continued evaluation of the interaction between marine mammals and salmon.

Transportation of fish around dams

Moving fish in barges or trucks benefits some fish but remains controversial. Transportation decisions are made by the fish managers in cooperation with the Corps which owns and operates the trucks and barges. Transportation is called for when fish survival is expected to be greater with transportation, usually in low water years. Substantial improvements to make transportation safer and more effective are also called for.

Increased river velocities to enhance travel time

Fish survival increases as travel time decreases, but there is little consensus on the effectiveness of individual measures. NPPC believes it would be a serious mistake to use lack of consensus as a reason to take no action, especially in light of the serious state of certain runs. None of the new measures below will violate flood control limits or the Vernita Bar agreement that protects the spawning area for upriver bright fall chinook in the Hanford Reach of the Columbia River. NPPC also has given the power system flexibility on how it acts to increase storage to shape flows for fish. Immediate measures call for:

- Increased flows in the Snake River during the spring migration aimed at providing a flow equivalent of at least 85,000 cubic feet per second by lowering Snake River pools to near minimum operating level and providing additional water out of Dworshak Dam.
- Deeper drawdowns of lower Snake River reservoirs by 1995 also have been called for because the immediate measures do not appear to be enough in themselves to rebuild some of the runs. These deeper drawdowns will be implemented unless they are found to be economically or structurally infeasible, biologically imprudent, or inconsistent with the Northwest Power Act. Operations, design, mitigation, and biological plans for reservoir drawdowns are due in 1993. The measure allows for full participation by the river interest groups in development of drawdown plans and provides for independent analysis.
- Operation of Brownlee Reservoir by Idaho Power Company so upper Snake River Basin water is passed to assist migrants and shifting system flood control storage from Brownlee to other Columbia projects in years when below average runoffs is forecast.
- Study of the potential for new storage in the Snake River Basin to provide additional water and a study to assess effects of changes in water quality on salmon and steelhead, as well as a regional assessment of water availability.
- Water efficiency improvements, water conservation, improved forecasting, water marketing, dry year option leasing, storage buy-backs and other measures to secure substantial additional Snake River water for spring migrants.
- Increased flows in the Columbia that aim to provide at least 200,000 cubic feet per second in the lowest water years with even higher flows in slightly better years.
- To evaluate benefits for Columbia summer migrants in low water years, provision of water from U.S. non-treaty storage and continued search for energy exchanges and other alternatives to make water available to fish.
- Due to uncertainty over the availability of out-of-region power, a call to the BPA to begin to secure options for more resources to ensure more flows for fish.

- A call to evaluate various options that could meet winter peaking needs and other power system changes that could make more water available for fish flows and reduce the impacts on the power system.

State Actions

- A call for states to conduct water availability studies, establish minimum instream flow levels, deny new water appropriations that would harm anadromous fish, and acquire water rights on a voluntary basis to improve fish flows.
- Improved enforcement of water rights at diversions, including measuring devices.

Adult fish returning to spawn

- Evaluation of the effectiveness of releasing cool water in late summer from Dworshak and Hells Canyon dams to lower water temperatures to benefit returning fall chinook and steelhead.
- Leaving bypass screens in place longer if necessary to prevent adult fish from falling back through the turbines.
- Improvements in adult ladders and operating criteria.
- Evaluation of the growing shad population to determine if it is clogging ladders and impeding adult salmon passage.
- Evaluation of video counting and monitoring adult passage with internal (PIT) tags.
- Assessment of using cool water in ladders and evaluation of the effects of zero nighttime flows on adult salmon in the lower Snake.

Note: This excerpt is reproduced directly from Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem. (ISG 1996).

Key Points of ISG Report

Conceptual Foundations in the Current Fish and Wildlife Program

As the ISG began development of a conceptual foundation, it looked first to the Columbia River Basin Fish and Wildlife Program to determine whether such a foundation already exists in that document. Our answer is yes and no. The Fish and Wildlife Program actually has several implied conceptual foundations. This is likely a result of the process through which it is created, in which recommendations from fish and wildlife managers and others are reviewed and adopted. Each participating agency or individual brings to the process some version of a conceptual foundation on which their recommendations are based. In nearly every instance, these conceptual foundations are not stated outright, but are only implied. In some cases, the foundations that make their way into the program through the adoption of specific measures are in conflict.

In the review of the Fish and Wildlife Program, the ISG analyzed the general assumptions that seem to determine the direction of program activities. The most fundamental assumption appears to be that the natural ecological processes that result in a healthy salmon population can be, to a large degree, circumvented, simplified and controlled by humans. Out of this context, the ISG drew three further assumptions.

1. The number of adult salmon made available to spawn is primarily a direct response to the number of smolts produced. (More young fish will automatically result in more adult spawners.)

2. Salmon production can be increased by actions taken within the river without accounting for conditions in the estuary or ocean.

3. Management actions will not compromise environmental attributes of the ecosystem that supports salmon.

These assumptions drive management toward actions that are best characterized as technological substitutes for ecological processes. They are often measures that respond to individual problems and they may be credible scientific approaches to those problems if they are reviewed in isolation: hatcheries and mechanisms for improving salmon survival at hydroelectric projects, for example, rather than actions that look at the broader context of salmon life history, behavior, and habitat. They reflect a good faith effort by the NPPC and the region's fisheries managers to recover salmon populations. However, the continuing decline of the basin's salmon populations indicates that the conceptual foundations in the current fish and wildlife programs and the actions based on those foundations are inadequate.

ISG Proposed Conceptual Foundation

The conceptual foundation the ISG proposes departs from some of those in the current program. It is not intended to validate measures in the program, nor does it derive out of those measures. It is instead designed to form a framework into which recovery measures can be integrated, when they are appropriate. It can provide a template against which recovery actions can be measured and evaluated.

In this proposed conceptual foundation, we treat the Columbia River and its tributaries as both a natural *and* a cultural system. A natural-cultural ecosystem encompasses all the ecological and social processes that link organisms, including humans, with their environments. This approach integrates the habitat of salmon and other wildlife, as well as human habitat, with land use and other cultural developments.

We draw our conceptual foundation from established ecological principles, based on what we understand about the decline of salmon populations and their habitat in the Columbia River Basin.

There are three critical elements of the conceptual foundation:

1. Restorations of Columbia River salmon must address the entire natural and cultural ecosystem, which encompasses the continuum of freshwater, estuarine and ocean habitats where salmon complete their life histories. This consideration includes human developments, as well as natural habitats.

2. Sustained salmon productivity requires a network of complex and interconnected habitats, which are created, altered, and maintained by natural physical processes in freshwater, the estuary, and the ocean. These diverse and high-quality habitats are crucial for salmon spawning, rearing, migration, maintenance of food webs and predator avoidance.

3. Life history diversity, genetic diversity, and metapopulation organization are ways salmon adapt to their complex and connected habitats. This biodiversity and its organization contribute to the ability of salmon to cope with the environmental variation that is typical of freshwater and saltwater environments.

The Natural-Cultural Ecosystem

We believe an ecosystem with a mix of natural and cultural features can still sustain a broad diversity of salmon populations in the Columbia River Basin. We call this ecosystem "normative," by which we mean an ecosystem where specific functional norms or standards that are essential to maintain diverse and productive populations are provided. In developing our definition of normative, we looked at what conditions lead to high levels of salmon productivity in less-constrained river systems, as well as in the historic Columbia River Basin.

Key among the conditions we define as normative is the availability of a continuum of high-quality habitat throughout the salmon life-cycle, from freshwater streams along the entire migratory path into and back out of the Pacific Ocean. This habitat varies from freshwater to saltwater, from fast-moving, gravel-bottom streams to deep pools and deeper seas. We assume that this habitat is dynamic, responding to daily, seasonal, annual or longer life-cycle changes. We also assume that a

diverse array of salmon populations and other occupants of this habitat have adapted over time to the majority of these natural changes. Under some circumstances, salmon in mainstem reaches and adjacent subbasins of the Columbia formed groups of interconnected populations, which we refer to as metapopulations.

Development of the Columbia River for hydropower, irrigation, navigation, and other purposes has led to a reduction in both the quantity and quality of salmon habitat, and most critical, a disruption in the continuum of that habitat. Depleted salmon populations cannot rebuild if any habitat that is critical during any of their life stages is seriously compromised.

Consequently, we believe that the most promising way to help salmon populations rebuild is to reduce or remove conditions that limit the restoration of high-quality salmon habitat at each of their life history stages. Our intent in describing a normative ecosystem for salmon is to point our key characteristics that are critical to their survival and productivity. Our description is necessarily general. Specific prescriptions, such as flow regimes, levels of stock diversity, etc., will need to be developed through a process that includes policy development and trade-offs between the natural and cultural elements of the ecosystem. The normative ecosystem is also dynamic. Conditions in the normative ecosystem will vary, progressing from the current state of the river toward historic conditions, based on the region's decisions and actions.

Productivity and the Network of Habitats

The Columbia River is a complex network of habitat types from the headwaters to the estuary. Populations of salmon, as well as other fauna and flora, are distributed throughout this network, thriving wherever there are sufficient resources to sustain their growth and reproduction. Some species are relatively localized, finding adequate resources within a narrow geographic range. These include resident fish. Others, such as anadromous salmon, require vast migrations and specific conditions at each "post" in those migrations, if they are to thrive.

The system of hydropower dams on the Columbia has greatly diminished the diversity of habitat once characteristic of this watershed. The dams severed the continuum of habitat, leaving very little riverine habitat left in the mainstem and isolating other types of habitat. Dams also altered flooding and draining patterns, which further reduced available habitat types and food webs in those habitats. Two key consequences of this loss of habitat diversity have been a reduction in the biodiversity of native salmon stocks and the proliferation of non-native species. Certain species have been able to adapt to conditions created by the dams, while others have not. For example, invertebrates, fish and plants that are not native to the Columbia have proliferated in the impounded river reaches rather than in free-flowing reaches, generally because impounded habitat is more homogeneous.

Normative river conditions are re-expressed at some distance downstream from dams—the further from the dam, the more habitat recovery occurs. This has been demonstrated on the Flathead and Clearwater rivers, for example. However, the mainstem dams on the Columbia and Snake rivers, for the most part, preclude such resetting of habitat conditions because water released from each dam pours directly into the reservoir behind the next downstream dam. The exception is the Hanford Reach on the mid-Columbia, the last free-flowing stretch of the river. The Hanford Reach provides a model of the productivity possible in river reaches that are not fully regulated by dams. It supports a healthy population of fall chinook capable of surviving downstream migration, harvest in the ocean and return upstream to spawn.

Life History Diversity and Metapopulation Organization

In their 1996 review of the status of Pacific salmon, the National Research Council recommended that salmon be viewed as metapopulations rather than as isolated stocks. This application of metapopulation concepts to natural populations is still being debated among scientists, so our inclusion of the metapopulation structure as it applies to salmon should be viewed as a hypothesis that requires further study and confirmation.

Metapopulations are groups of local populations that are linked by individuals that stray among the populations. Metapopulations persist through the mechanism of straying. When local populations become extinct, they can be re-established through colonization by strays from neighboring local populations. We believe that metapopulation structure is likely in salmon because these fish display both a high degree of homing to their natal streams, which establishes the groups of local populations, and a variable level of straying, which provides the dispersal of genetic traits needed to successfully recolonize habitat vacated by lost populations.

Studies indicate that the most abundant salmon spawning populations likely occurred in river segments with well-developed floodplains and gravel bars, where habitat complexity was high, including areas suitable to spawning, egg incubation, and juvenile rearing. We conclude that salmon populations spawning in large alluvial mainstem reaches of the Columbia may have served as core populations and, as such, may have played critical roles in sustaining salmonid populations in the basin.

Loss of prime mainstem spawning habitat for core populations, and further losses from fragmentation, isolation and degradation of habitats in tributary systems, could have significantly reduced the long-term persistence and stability of regional salmon production. For example, most fall chinook that spawned in the mainstem Columbia and Snake rivers are now extinct.

One of the only surviving mainstem populations and fall chinook spawns is in the Hanford Reach in the mid-Columbia. This is the largest naturally spawning population of chinook salmon above Bonneville Dam, and it has been stable during the years when salmon in other parts of the basin have undergone severe decline. It is possible that fall chinook in the Hanford Reach now function as a core population, which might serve as a source for colonization of adjacent habitats if normative conditions were restored in those areas.

Isolated population of salmon are less likely to be recolonized should they be driven toward extinction because they may lack adjacent populations with similar genetic traits. For the same reason, surviving isolated populations also have less likelihood of successfully contributing to efforts to replenish declining populations elsewhere in the basin. As populations become isolated, local extinctions become permanent, and the entire metapopulation moves toward extinction. Therefore, we believe that restoring salmon populations in this basin will require both the restoration of more diverse habitat conditions and the reconnecting of habitats into the continuum necessary to support salmonids at every stage of their life histories. If this continuum can be restored, we believe that metapopulations will re-emerge to help stabilize regional salmon populations against environmental fluctuations.

Assessment of the Fish and Wildlife Program

In its review of the scientific basis of the Fish and Wildlife Program, the ISG assigned a qualitative rating that summarized its assessment of the scientific support for various assumptions. Its numeric rating ranked assumptions and principles based on what we deem the "level of proof." "Level one" would apply to an assumption for which there is solid peer-reviewed empirical evidence. "Level two" would be backed by strong evidence, but not conclusive evidence. "Level three" assumptions have theoretical support with some evidence. "Level four" assumptions are speculative, with little empirical evidence to support them. Finally, "level five" assumptions are contradicted by good evidence to the contrary. Chapters 4 through 10 contain our analysis of the data we reviewed to establish these conclusions.

The ISG first reviewed three general principles that appear in both the NPPC's program and in the Northwest Power Act.

1. *The salmon bearing ecosystem in the Pacific Northwest and northeast Pacific Ocean has considerable excess carrying capacity.* Level of proof: four. This assumption leads to the further assumption that there is a simple relationship between the numbers of smolts and increasing overall productivity over the long term. What confounds this assumption is the complexity of both freshwater and marine conditions. In-river, estuary, and ocean environments fluctuate dramatically in response to both human-caused and environmental changes. The key to resilience in a variable environment is not just the numbers of smolts nor the quantity; it is the diversity of both habitat and genetic traits that is critical to restoring Columbia Basin salmon.

2. *Abundance of salmon and steelhead in the Columbia River Basin has, to a significant degree, declined due to, and is presently limited by, human actions.* Level of proof: one. This assumption is irrefutable. Even accounting for natural variation in the environment, decline of most species has closely paralleled the development of the basin. Damage from early and ongoing development has removed substantial portions of the basin from access by salmon, altered remaining habitat, reduced the abundance of salmon and decreased the ability of surviving salmon populations to cope with natural environmental variations. Focusing only on hydropower impacts severely constrains the region's ability to reverse these trends.

3. *Ecosystem functions lost as a result of development of the Columbia River can be replaced by technological solutions to individual problems.* Level of proof: four. The best evidence against this assumption is the continuing decline of the basin's salmon populations. While technology will continue to be part of any restoration effort in the Columbia River, the ISG recommends that the region move from a strategy of "fixing" ecosystem damage to one that places greater reliance on re-expression of the natural biological and physical processes of the Columbia River salmon-bearing ecosystem.

The ISG also analyzed 29 specific assumptions contained in the Fish and Wildlife Program, assigned a numeric ranking to each, and provide in Chapter 3 a brief overview of the science supporting our ranking. In Chapters 4 through 10, we expand on this evidence.

General and Specific Conclusions Related to Mainstem Survival

As the ISG noted, restoration of Columbia River Basin salmon populations will require a new definition and understanding of the salmon ecosystem. Humans have transformed the Columbia River Basin from a thriving natural environment to a great hydroelectric, irrigation, and transportation system, one that drives this region's economy. The human approach to salmon recovery has reflected these impressive technological accomplishments: hatcheries have attempted to replace natural productivity, flow augmentation has attempted to replace the spring freshet, barge transportation has attempted to replace inriver migration, and so on. To reverse the decline of salmon populations, we believe the region must endorse a conceptual foundation for salmon recovery, such as the one previously described, and base its efforts on that foundation.

The key to salmon productivity in the future will be the degree to which normative ecosystem conditions are re-introduced into the Columbia River Basin. To accomplish this return to normative conditions, we recommend the following.

Recognize explicitly that salmon in the Columbia River Basin exist naturally as collections of locally adapted populations organized into aggregates of core and satellite populations known as metapopulations. To increase total productivity, management decisions should nurture life history and population diversity. That diversity will require protection for the remaining core populations, and restoration and reconnection of potential core habitats at strategic areas within the basin. The Hanford Reach, the last free-flowing stretch of the Columbia, could be a model for this management approach.

Protect and restore freshwater habitat for all life history stages, with a focus on key Columbia River and tributary reaches and lakes. This approach would include: restoration of the spring freshet to revitalize in-river habitats; stabilization of daily fluctuations in flows to allow food webs to persist in shallow-water habitats that are important juvenile rearing areas; provision of incentives for watershed planning that emphasized riparian and upland land-use activities to enhance instream and lake habitats. Wherever possible, reconnect restored tributary habitats to restored mainstem habitats, particularly where remnant core populations, such as the Hanford Reach fall chinook, exist.

Manage stocks with a more complete understanding of migratory behavior and the limitations that migratory behavior could place on river operations. From their review, the ISG concluded that the Columbia and Snake rivers should not be treated merely as conduits through which young salmon passively migrate to the sea. On the contrary, the young fish have ecological requirements that must be met during their downstream migration through the mainstem habitat. Fishery managers need to better understand these needs and manage accordingly.

Reduce sources of mortality throughout the salmonid ecosystem, including the ocean and the estuary, as well as the rivers and tributaries of the Columbia River Basin.

Current and future salmon recovery measures should correspond to the normative ecosystem concept and be evaluated for their effectiveness in meeting stated objectives. For example, an approach whose goal is a normative ecosystem would highlight restoration of life history diversity,

rather than more technological approaches, such as transporting fish in barges or producing them in hatcheries. Hatcheries and transportation should only be used selectively and experimentally, and they should be monitored carefully. The has attempted to replace as a whole needs an integrated ecosystem monitoring and evaluation program.

For more information on the
Lower Snake River
Juvenile Salmon Migration Feasibility Study

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